Pan American's Planned Maintenance Control System

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ABSTRACT

Pan American World Airways is proceeding with a modular development program from the foundation and framework designed in the "Maintenance Control System" (MCS) Master Plan. Pan Am began to anticipate and be prepared for the growing services that will be required by the increasing fleet, particularly the 747's and prospects of the Concorde and the U.S.-SST.

MCS is a management information system that incorporates all the control functions of maintenance into an integrated operation. MCS encompasses 12 major functional subsystems supporting scheduling, forecasting, performance evaluation, modifications, and improvement functions at all levels of maintenance management from the Production Foreman to the Vice-President.

OBJECTIVES

The overall objectives given to the design team by Pan Am management were to develop MCS as fully integrated information system that would: (1) present accurate maintenance information to promote increased aircraft utilization, improve maintenance efficiency and optimize aircraft reliability, (2) operate economically with respect to manpower and other costs as well as implementation timing and payoff period, (3) enable management and operating personnel to make timely decisions regarding operations planning and control, and (4) function with sufficient flexibility and evolutionary growth potential to meet the current and future requirements of Pan Am's maintenance operations through the 70's. In effect, the objective of MCS is to develop a cost-effective system which links the functional entities of maintenance into a unified management control system and make use of common data in its operation.

MCS SCOPE

The 12 subsystems of MCS mirror Pan Am's management maintenance activities, and also provide improved capabilities through the application of advanced techniques, better information collection, processing, and dissemination. Each subsystem performs specific control functions of its own, but when MCS is viewed in its totality these subsystems interrelate with one another both functionally and through the use of common information. In this fashion not only is economical information handling achieved, but better overall management control is effected. For example, the work to be accomplished on an aircraft is developed in the Aircraft Service Work Planning and Control Subsystem. Specific times and places for component replacements are thereby generated. This information is used not only to control aircraft maintenance work, but is employed by the Shop Scheduling subsystem to determine all shop production requirements needed to support aircraft services. The two subsystems, therefore, operate as a functional entity to construct an over-all flow of work which balances manpower and material costs with aircraft operating schedules.

MCS DEVELOPMENT PLAN

The Maintenance Control System effort was largely carried out by a group of Systems Analysts aided by consultants and approximately 49 operating personnel who actively participated in determining the detailed requirements through regular Task Force meetings and special assignments. The project has, from time to time been guided by a steering group consisting of Maintenance Line Managers and an Advisory Committee consisting of representatives from Data Reduction, Maintenance Cost Accounting, Budgeting, Supply, Treasury, and Flight and Ground Operations.

The MCS development plan was divided into three phases:

Phase I: "Master Plan"

Phase II: "Detail Master Plan"

Phase III: "Implement System"

Phase I, "Master Plan," was completed in December 1968. Generally, the task was to study the present methods and concepts in all areas of maintenance and development a conceptual "Master Plan" for an improved Maintenance Control System. This "Master Plan" identified all subsystems, their interrelationships, their expected payoff, and the new methods and techniques necessary to achieve payoffs. In addition, general data processing and communicating equipment requirements were estimated. The plan specified a general implementation schedule for the Maintenance Control System, a yearly cost to operate the system, and the detailed manpower and equipment costs required to develop Phase II.

Phase IIA of Phase II was completed in mid 1970. Phase IIA verified gross cost avoidance (savings) by detailing areas of the Master Plan identified in Phase I. In view of the size and complexity of the project, it was decided to detail the functional requirements which would complete Phase II and implement, Phase III, in a modular building block approach.

Phase II, "Detail Master Plan," is presently in progress and scheduled for accomplishment by modules. The major Phase II tasks are: detail inputs, outputs, and logical procedures for all systems; detail data processing and communications equipment requirements; detail the computer programming manpower requirements; detail the capital requirements and yearly operating cost for each module as they are completed.

In Phase III, the equipment will be installed, computer programs written and checked out, training performed, and system tests and operational phase-in accomplished.

MCS DESIGN APPROACH

A major design problem had to be overcome in Phase I--how to construct an overall picture of the maintenance control process which would identify the areas of greatest improvement, and ensure that the new system would be properly integrated. It was recognized that integration had to be achieved from three viewpoints.

- Function (the logic of the control process)
- Information (the economic employment of common data)
- Execution (the balance of equipment and men to best perform the tasks of maintenance)

The Pan Am design team adopted a functional approach toward developing design specifications for the MCS. The functional approach was adopted for two primary reasons. First, to improve maintenance management control it is not enough to build large data bases without a thorough understanding of the control process. Second, the operation cannot be analyzed solely from the viewpoint of individual organizations since the performance of most control functions involve many organizations. For example, developing effective maintenance engineering improvements involves not only Reliability and Engineering, but Production, Production Control, and higher management review and evaluation.

The approach focused upon developing a clear description of the flow of work, manpower, and materials, as well as of the aircraft themselves. This description was formulated into a model of the Operating Environment. This Operating Environment was then analyzed to determine the control points, the factors affected by control, and the relationships between controls. Control points were then related to control functions, which in turn became the basis for defining and designing the 12 subsystems. In the context of the Operating Environment, the way in which controls operate upon one another was determined.

The dynamics of the situation were identified in terms of such relationships as the changing of removal rates and inventory replenishment times and their effect on provisioning levels, scheduling decisions, and engineering modifications. As a result, performance feedback monitoring points were established and evaluation approaches defined.

The present system design considers functional requirements, a common data base, data processing equipment requirements, and manual procedures as a total system.

MCS DESIGN

The basic functional areas of MCS are:

- Planning--through forecasting
- Controlling--through scheduling
- Performance Evaluation--through monitoring and the execution of corrective action

In total these areas contain 12 functional subsystems. The subsystems and the primary functional areas of maintenance they support are:

- Routing and Aircraft Service Forecasting (forecasting, scheduling)
- Diagnostics (monitoring)
- Provisioning (forecasting)
- Manpower--Shop Load Forecasting (forecasting)
- Modification (monitoring, scheduling, forecasting)
- Parts Identification (monitoring and scheduling)
- Ground Support Equipment (scheduling)
- A/C Service Work Planning/Control (scheduling)
- Personnel (forecasting, scheduling, monitoring, and improvement)
- Powerplant/Rotable Shop Scheduling (scheduling)
- Warranty Claims (forecasting, scheduling, and monitoring)
- Cost/Performance (monitoring--this subsystem synthesizes the monitoring of all subsystems to provide an overall evaluation capability)

SUBSYSTEM DESCRIPTION

The 12 functional subsystems of the MCS each provide an improved method of performing critical maintenance activities. Each subsystem is briefly described in the following paragraphs in terms of its objective, basic approach, and area of improvement.

1. Routing and Aircraft Service Forecasting

   This subsystem uses computer-generated displays to provide accurate aircraft status data and determine the effects on airline operation and maintenance service schedules for each alternative aircraft assignment to routes. Final decision is made by the personnel responsible for aircraft routing. As a result of that decision, the computer automatically adjusts short-range service requirements. Through this subsystem it is expected that delays can be reduced, better customer service provided, and greater time between services realized with attendant service cost avoidance.

2. Diagnostics Subsystem

   In this subsystem information describing the performance of aircraft and the systems and subsystems on the aircraft will be made available on demand to assist in resolving enroute problems. In addition statistical trend monitoring will be performed and automatic alerts generated in order to initiate appropriate long-range engineering improvements. A special computer-based engine performance analysis capability will be provided. Detailed aircraft historical information will be derived from a data base which includes flight log, shop findings, structural findings, and delay summary information. In addition to improved equipment performance, this subsystem will reduce the manpower required to process report data.

3. Provisioning Subsystem (Management of Present Inventory)

   This system is basically concerned with the reprovisioning of components and repairable parts. In conjuction with other subsystems such as Cost/Performance, Shop Scheduling and Diagnostics a capability will be provided to monitor inventory movement and removal rates. As a result of significant changes better inventory levels will be established. Based upon computer-aided analysis this subsystem will determine inventory requirements by examining the tradeoff between operating requirements and inventory costs: units will be allocated to reduce exposure to aircraft delays.

4. Manpower Forecasting Subsystem

   This subsystem provides computer-generated shop load and manpower forecasts. The subsystem will develop these forecasts from aircraft and inventory utilization data as well as flight hours and manhour standards information. This subsystem will, together with the Cost/Performance subsystem, provide computer-generated budgets.

5. Modification Subsystem

   In this subsystem computer assistance is provided to help schedule modification and record compliance when modifications are accomplished. This subsystem in conjunction with Diagnostics and Cost/Performance provides computer-based reliability and cost alerts to initiate action. In addition, a computer-generated report describing modifications effectiveness will be produced.

6. Parts Identification Subsystem

   This subsystem provides a common index and file of up-to-date parts listings processed automatically in order for the machine to obtain parts more rapidly and accurately. Computer-generated parts catalogs will list manufacturers part number together with stock part number and aircraft effectivity data. Catalog information will be contained on microfilm generated from the up-to-date computer magnetic tape master file.

7. Ground Support Equipment Subsystem

   This subsystem uses computer-generated information to schedule preventive maintenance on support equipment, control the scheduling of vehicle maintenance, and monitor vehicle performance. As a result, improvements can be achieved in increased availability of support equipment and decreased equipment requirements while maintaining required support levels, extending equipment life, and increasing labor availability.

8. Aircraft Service Work Planning/Control Subsystem

   This provides more effective manpower allocation and makes aircraft services more efficient through the use of a computer-based network plan showing work flow and resource requirements.

9. Personnel Subsystem

   The Personnel subsystem uses a computer-based personnel availability and skill inventory. This data, through integration with the manpower forecasting subsystem, forecasts new personnel requirements. The subsystem is also used to determine overtime eligibility to reduce the manhours required by foremen in making overtime assignments.

10. Powerplant/Rotable Shop Scheduling Subsystem

    This subsystem involves computer-based inventory status monitoring world-wide, demand analysis, processing time computations, and workload estimation to generate shop production schedules which balance resources against production requirements. Final

10. decisions will remain, however, in the hands of cognizant Production and Production Control personnel. Inventory reductions through decreased through-put time and improved operational support will result.

11. Warranty Claims Subsystem

    This subsystem automatically provides listings of warranty items to determine accurately the dollar value of recovered claims and compute actual MTBF versus that warranteed. It also monitors vendor performance in conjunction with the Cost/Performance subsystem and computes warranty spares requirements due to vendor supply times and MTBF.

12. Cost/Performance Subsystem

    This subsystem involves the collection, analysis, and dissemination to management of the information necessary to determine areas of maintenance which can be improved. This information will also ensure the collection and processing of customer billing data and maintenance budgets. Based upon both historical and engineered work standards a many-level exception reporting system has been developed to highlight trends and unusual performance in aircraft, systems, engines, and components. Besides costs and labor distribution data, the subsystem will analyze other pertinent maintenance performance indicators such as material delays, personnel shortages, etc.

MCS INFORMATION INTEGRATION

As an example of the way in which these subsystems employ common information a data base contains information related to manpower, support, equipment, parts, and aircraft. Within the data files of parts and aircraft there are data elements such as unit <u>header identification</u> (component code number, costs, time limit, removal rate), <u>individual unit</u> identification (modification warranty claims, etc.), <u>part status</u> (on aircraft, in transit, in shop, etc.), and <u>history</u> (aircraft hours at removal, unit time since overhaul "TSO", removal reason, etc.). The file is activated when a unit is replaced and the Routing subystem provides the aircraft hours at time of transaction. Information transfer within the file occurs by taking the time limit and aircraft hours together with the unit serial number to update the aircraft status file. The unit removed is checked for possible warranty and is put in transit where the scheduling subsystem is notified of a line station demand. Unit in-transit time is then monitored to keep inventory moving. In addition, the history data set is updated through the diagnostics subsystem, where removal rates are calculated and through alerts engineering is notified of possible unit deficiencies. The removal rates are also utilized to predict unscheduled removals for the Manpower Forecasting/Shop Load subsystem. The unscheduled removal prediction is combined with the scheduled removals, through the Aircraft Service Scheduling subsystem, and the total manpower forecast and shop scheduling demands are determined. The result is an integration of functions and information controlling the operating environment.

EQUIPMENT SELECTION

Final equipment selection has not yet been completed although certain basic requirements are known. Preliminary plans indicate that MCS will use a central computer facility which is in communication with Line Stations and other outlying maintenance areas. Shops and aircraft service locations will provide status information through data collection devices. Certain subsystems will directly access the computer for information whenever the need arises. A significant equipment economy is achieved through developing an integrated system concept because the equipment which may not have been justifiable for a single subsystem becomes so when used to support many subsystems. This allows the designer to attack the problem on a broader base without having to take secondary approaches due to lack of equipment.

THE MAN IN MCS

Much emphasis in this report has been placed upon the role of data processing equipment. Throughout the effort Pan American management as well as the Pan Am design team have continued to emphasize two other aspects of system development. First, the system must have a payoff, not just technical sophistication. Second, the role of the maintenance personnel in making the system work must not be ignored. Computers alone cannot improve maintenance. Through task forces composed of operating personnel, as well as other communication between designers and management, the MCS development approach hopes to ensure that people as well as equipment play their role. If there is any single lesson of importance to be derived from developing this kind of system, it is that the role of management and operating personnel in the system must be understood from early development through actual operation.